

VERY HIGH-INTENSITY  $\pi$  BEAMS

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A very simple calculation shows that it will be possible to obtain at NAL pion beams of very high intensity.

Assuming  $5 \times 10^{13}$  protons per pulse and a charged multiplicity of 6 we see that there will be  $3 \times 10^{14}$  pions produced per pulse. Assuming equal numbers of  $\pi^+$  and  $\pi^-$  we get about  $10^{14}$  pions per pulse of each polarity. Within a factor of two the production cross section will be flat in the region  $30 \rightarrow 70$  GeV/c where the pion flux is at a maximum. Thus, if we take a momentum bite of 1% ( $\Delta p/p = \pm 1/2\%$ ) then we will get about 1% of the total flux in each momentum bin. Total number of  $\pi$ 's with  $\Delta p/p = \pm 1/2\% \approx 10^{12}$ /pulse for  $30 < p_0 < 70$  GeV/c.

Now the differential cross section is roughly given by

$$\frac{d^2\sigma}{d\Omega dP} \propto e^{-3.5P_{\perp}}$$

The rms angle is given by

$$p\theta_{\text{rms}} \approx \frac{1}{\sqrt{2} \sqrt{3.5}} \approx 0.4 \text{ GeV/c rad.}$$

This then turns out to be

$$\theta_{\text{rms}} = \begin{cases} 13 \text{ mrad} & 30 \text{ GeV/c} \\ 5 \text{ mrad} & 70 \text{ GeV/c} \end{cases}$$

It should thus be possible to design magnets to catch at least 1/3 of the flux at each momentum. Consequently, it will be possible to have beams of

$$I_0 \approx 3 \times 10^{11} \text{ } \pi' \text{ s/pulse} \begin{cases} p_0 = 30 \rightarrow 70 \text{ GeV/c} \\ \Delta p/p = \pm 1/2\% \end{cases}$$

This possibility, of course, brings both advantages and problems.

The advantage is the ability to do whole new classes of experiments.

- (i)  $\pi$ -p elastic scattering up to  $P_{\perp}^2 \approx 8-10 (\text{GeV/c})^2$
- (ii) particle production cross sections in  $\pi$ -p collisions
- (iii) inelastic  $\pi$ -p collisions at high  $P_{\perp}^2$

The problem will be handling such a lethal secondary beam. This will be similar in beam power to the ZGS extracted proton beam. It will need at least 6 ft of concrete shielding around it and a beam stop at the end.

The techniques used in doing experiments with this beam will be quite similar to those employed with p-p interactions with the Argonne and CERN slow EPB's. The fluxes can be measured by radiochemical analysis. The only problem will be the several million dollars needed

for the shielding around this pion beam. I believe that the physics opened by this beam justifies this expense.

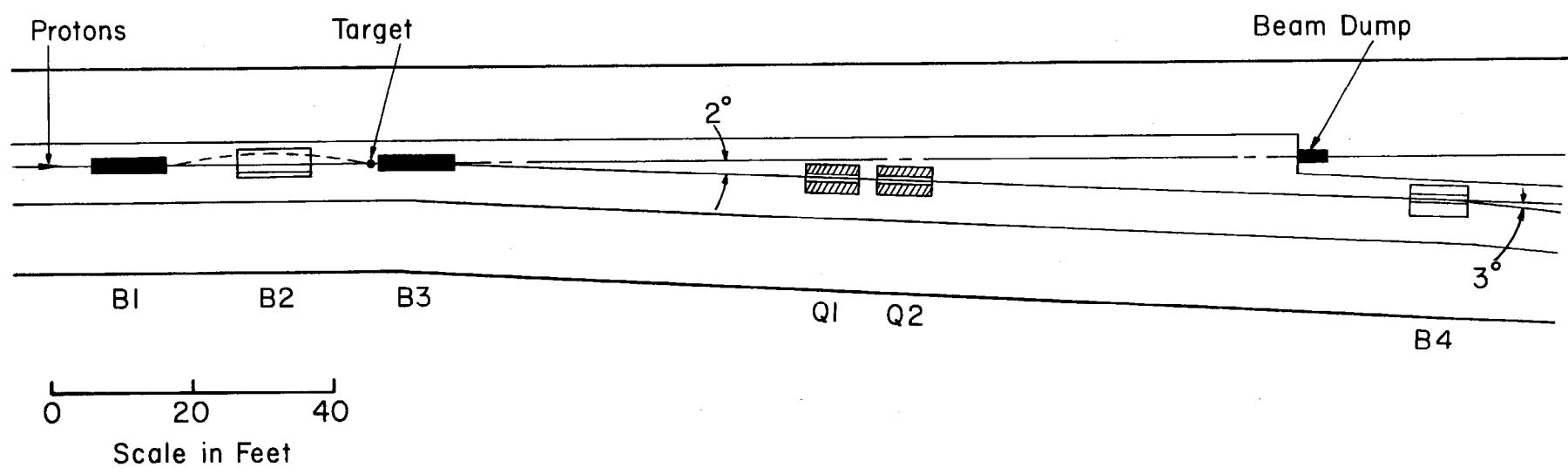
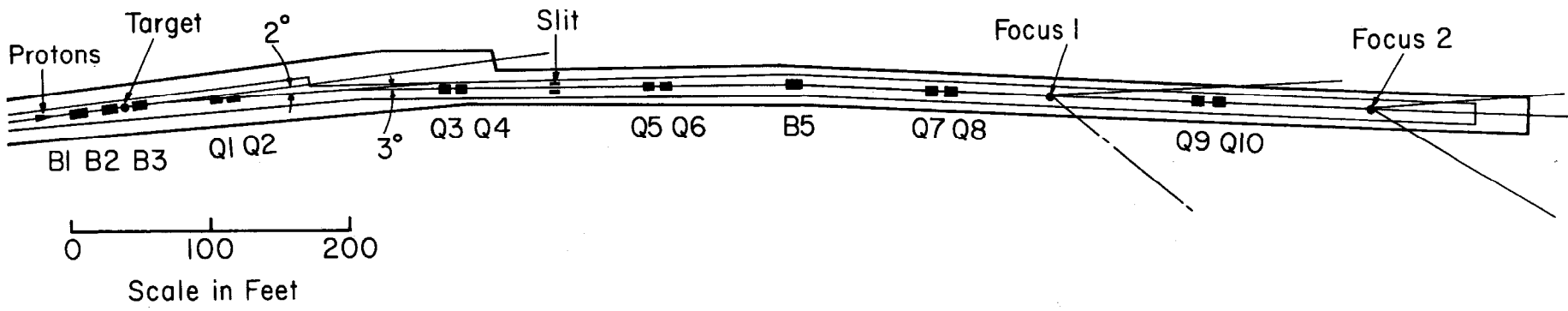


Fig. 1. Layout of a high-intensity pion beam, carrying up to  $3 \times 10^{11}$  pions per pulse. The lower part of the drawing shows the target region on an expanded scale.